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UNITED STATES DEPARTMENT OF AGRICULTURE
WEATHER BUREAU
Instrument Division

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GENERAL INSTRUCTIONS FOR INSTALLATION, CARE, AND REPAIR
OF CEILING-LIGHT PROJECTORS.

1. Permission to use site:- Written permission to use the site and to run wires must be had from the proper authority before proceeding with the work. In some cases such permission is already in effect. Information required for preparation of agreement is outlined in Instrument Division mimeographed circular revised February 1, 1931, "Quarters and Instrumental Equipment for Weather Bureau Stations at Airports."
2. Location of projector.- The projector will be placed not less than 500 feet nor as a rule more than 1000 feet distant from the observing point (measured horizontally) as directed by Weather Bureau official. Actual distance should be given in invitation to bidders. The longer base line is preferred especially in mountainous country. Accessibility for cleaning, and opportunity for running cable must be considered. It is not necessary that projector and observing point be at the same level when clinometer is used. The line of sight from switch to projector should be out of glaring lights, and preferably with the projector to northward of switch in order to avoid interference by moonlight.
3. Location of control switch.- The control switch should be located outdoors in a place where the observer will be somewhat out of the glare of lights so that by noticing the effects of turning it on and off occasionally he can be assured that the projector lamp is burning.
4. Setting up projector over ground.- Projectors serially numbered 301 or higher are provided with a slip fitter for mounting at the top of a 4-inch iron pipe. This device slips over the top of the pipe and is then clamped to it by set screws. The pipe need not be threaded. A section of 4-inch pipe 6 feet long is set 3 feet in the ground. A flat stone or equivalent should be placed under the end of the pipe. The ground should be thoroughly tamped about the lower end of the pipe to make sure of rigidity. A collar of cement concrete about 4 inches thick and extending about 8 inches beyond the pipe will then be provided at the surface of the ground to hold the pipe firm.
5. Setting up projector over wood platform, concrete slab, or rock.- For such installation a 3-foot section of 4-inch pipe should be employed, the lower end being screw threaded and fitted with a cast iron flange (about 9 inches diameter according to plumber's supply catalogs). The flange should then be firmly secured by bolts or by lag screws with expansion shields, as may be appropriate.
6. Setting up projector equipped with flanged base.- In case the projector is itself fitted with a flanged base the top end of the 4-inch pipe will be screw threaded and a 4-inch flange screwed thereon to form a seat. The projector will be secured to this seat by $\frac{3}{8}$ inch through bolts. A cork gasket will be inserted between the two flanges.

1944

7. Orientation of projector.- In case a building, cliff, or other object affords a focussing target the projector will be oriented so that it may be conveniently directed thereon. Otherwise it will be oriented so that the beam may be directed either toward the observing point or to the zenith.

8. Conductors.- In order to keep down line drop in potential No. 10 gage will be employed for lines up to about 600 feet in length; No. 8 gage for lines 600 to 1000 feet. Extensions to existing installations will be No. 8 gage. Exceptions to this rule may at times be justified where it is desired to utilize surplus No. 10 cable already the property of the government.

9. Cable specifications.- The following will be used for the procurement of cable for underground use in installing projectors:

"Cable, steel taped, 2-conductor, No.....gage, solid copper wire, manufactured in accordance with Specifications No. 720, Air Navigation Division, Aeronautics Branch, Department of Commerce".

10. Reels.- Invitations to bidders should contain a statement to the effect that reels will remain the property of the successful bidder and will be returned at government expense, and if not so returned within a designated time, usually twelve months, will be paid for by the government at a price of, to be named by contractor.

11. Control switch.- A post about 6-1/2 feet long, 5-inches across the top, of wood known to last well in the ground will be set 3 feet in the ground. At the upper part of the post a flat surface will be provided. A safety weather proof switch 2-pole 30-ampere, Crouse-Hinds FA 328 or equal, for outside use will be bolted to the post near the upper end.

12. Laying underground cable.- The cable will be buried in a trench deep enough to be safe from injury, the depth to be designated by Weather Bureau official. This requirement may need to be modified in case of rock formation or other circumstances that render it unreasonably costly. In some instances the Weather Bureau may furnish the cable in more than one length. The contractor will then furnish suitable Standard Underground Cable Company's joint boxes or equal and make waterproof splices.

13. Wiring from cable to switch.- Wires from underground cable to switch will be No. 12 stranded in conduit from an Underground Cable Company's joint box or equal placed at post.

14. Wiring from cable to projector.- The following plan is recommended where appearance is important: A rectangular hole large enough to admit the cable will be cut in the 4-inch pipe, lower edge of hole 2 feet above lower end of pipe; also a 1/2-inch drainage hole will be drilled in the 4-inch pipe at a point 3 feet 1 inch above the lower end. Weather

proof leads, #12 stranded copper, including 2 feet spare length will be spliced to ends of cable conductors (suitable rubber-covered 2-conductor cable already provided with some projectors may be utilized in this connection). Leads and cable will then be drawn upward through the rectangular hole so that splices and spare length may be coiled within the pipe near the top. In case the contractor is not prepared to cut the rectangular hole he may thread the cable through the lower end of the 4 inch pipe provided it be bent over a long radius and provided also the lower end of pipe be supported on several flat stones. The pipe will then be filled with loose fine gravel or fine crushed rock to a depth of 3 feet. Next a 1-inch layer of bituminous water-proof compound will be inserted, the top of the layer to slant towards the 1/2-inch drainage hole. This layer of compound is designed to lessen moisture that otherwise might find entrance from the lower end of the pipe and cause trouble through condensation, while the 1/2-inch hole is intended to provide drainage in case water should accidentally get into the pipe. The extra length of #12 lead is intended for possible future requirements. The terminals of leads should then be threaded through bushed hole in slip fitter and through the opening in the projector drum, and connected under binding screws on the lamp socket.

Where appearance is not important the contractor may run the cable direct to a waterproof junction box clamped to the outside of the 4-inch pipe. Leads will then run from junction box to the lamp in the projector. In this case there will be no wires inside the 4-inch pipe.

15. Wiring, inside.- For inside wiring No. 10 BX stranded will be used for dry locations; No. 10 BXL stranded for damp locations.

16. Code compliance.- All wiring shall comply with National Electrical Code requirements and with local regulations.

17. Painting.- Pipe in the ground will be given one coat of asphaltum. Pipe above ground will be given a prime coat of oxide paint for iron and a top coat of aluminum. The switch post will be painted to conform with surroundings.

18. Procedure to be followed in inviting bids.- Bids should be invited on Form 33. The invitation should contain a general statement of the work to be performed; a statement of size and length of cable, and depth of trench; a list of materials, including projector, to be supplied by the Weather Bureau; a list of the materials such as cable, switch, splice boxes, posts, and necessary accessories to be supplied by the contractor; a statement as to National Electric code compliance; and a statement that all materials and work furnished by contractor must be to the satisfaction of Weather Bureau representatives. The invitation should also call attention of bidders to the need for statement as to American origin of materials used. Bidders should be made acquainted with the need for stating a time for acceptance far enough in advance to permit the papers to be passed upon by the Department of Agriculture in Washington.



19. Completion of work--Inspection.- Upon completion of work the contractor will remove all excess materials and leave premises in good condition. All material excavated from trenches will be replaced therein after installation of cable. All work shall be done in a thorough, neat and workmanlike manner, the contractor being responsible for any damage done to private property. Upon completion the job will be subject to the inspection and acceptance of Weather Bureau representative before payment is made.

20. Lamps.- The projectors are all equipped with parabolic reflectors. The theoretically best lamp for use would be one in which the source of light is a brilliant point. The carbon arc is nearly a point source of light and is most brilliant; but practical considerations are against its use for the purpose. Hence incandescent lamps of a type in which the luminous filament is concentrated in a small space are furnished by the Weather Bureau. Such filaments as found in the G or globe shaped lamps are identified by the manufacturers as the C-5. A flat filament known as C-13 is built into the T or tubular shaped bulbs.

Lamps most used in ceiling light projectors:

Bulb	Watts	Light	Filament	Base
		Center Length (Inches)		
G-30	250	3	C-5	Mogul screw.
G-40	500	4-1/4	C-5	Mogul screw.
T-20	1000	4-3/4	C-13	Mogul screw.

21. Choice of lamp.- Projectors serially numbered 301 or higher will take either G-30, G-40, or T-20 lamp. When changing lamps, particularly from one type to another, the socket adjustment may need to be changed because the light center length (the distance from tip of base to luminous filament) is not the same for all lamps. The T-20 1000-watt is recommended for use only where previous trial has established its suitability. The G-30 250-watt lamp has been most widely used in projectors, but some complaint of insufficient light from it has been made. The main reason for preferring the G or round globe type is that such lamps are designed to be burned base horizontal. The T or tubular shaped lamps are designed to be burned base down; however they are being used base horizontal at some stations without serious overheating, probably because of the short time required to make an observation; other stations have experienced distortion of the heat softened bulb by expansion of the inclosed inert gas.

22. Effect of heat.- In the use of the higher power lamp there is serious risk of damage to mirror and to cover glass by the intense heat, particularly if turned on longer than a few minutes. Only in extreme cases where the general illumination of the sky is strong is the 1000-watt lamp considered justified. For stations requiring this special treatment a G-40 1000-watt lamp is now being tested.

23. Voltage.- Effort is made to stock the G-30 and G-40 lamps in voltages 90, 100, 105, 110, 115, and 120, in order that the measured socket voltage may be reasonably well matched. Requisitions for lamps should specify style and size of bulb, wattage, and voltage desired. If the rated lamp voltage is higher than the actual voltage the intensity of beam will be lessened. If lower the life of the lamp will be shortened. When screwing lamps into or out of sockets they should not be grasped by the part that has large diameter because the greater leverage may break the seal between brass and glass. It is a good plan to apply a little graphite to the threads of the brass base.

24. Focussing of lamps.- It is of extreme importance that the lamp be in focus. Only a slight out of focus condition may reduce the light spot to half its intensity. A method of becoming familiar with the adjustments tried in the Instrument Division is to direct the beam upon a target which may be a sheet of white cloth three or four feet square stretched between two rods, or some equivalent arrangement. The target need not be more than 40 feet or so distant. In nearly all projectors the lamp sockets are built upon stems that provide an adjustment of several inches transverse to the axis of the mirror; additional adjustments permit smaller movement of the lamp either transversely across the axis of the mirror or longitudinally with the axis in a way to place it nearer to or farther from the mirror. It is suggested that all employees responsible for measuring ceiling lights familiarize themselves with these adjustments. Possibly this can best be done on a cloudy day when the light spot on a screen can be observed with the adjusting screws in plain view at the same time. It is helpful to put a few drops of light machine oil on the threads of the adjusting screws to make them run free. Furthermore mechanical features such as springs employed in the focussing adjustments of some projectors should be examined to make sure that they are functioning. Lamp sockets should be so firmly held that the lamp will be in the same position relative to drum whether beam is directed horizontally or vertically. Final check upon correct focus is by observation of the light spot upon a well defined cloud layer at night, and by inspection of the vertically projected beam as it illuminates dust particles, etc. in its path. The best focus is realized with the smallest obtainable spot on a well defined cloud layer or with the narrowest projected beam through the air. The rays should not cross each other. Projectors are provided with two peep holes and marks opposite on the inside of the drum, usually in the form of a + or of a punch mark. These marks were originally placed in the factory by sighting from the peep holes through the focussed lamp filament. Hence if any suitable lamp is thereafter so adjusted as to bring the filament within the two lines of sight it will be very nearly in focus; but a finer adjustment should be made subsequently. The wires inside the drum that lead to the lamp socket should be free. Otherwise they may interfere with correct focussing, or may subsequently pull the lamp out of focus.

25. Slippage of mirror.- Glass mirrors are necessarily rather loosely mounted to allow for expansion and contraction. Occasions are known of a slight edgewise shift of the mirror with the beam horizontal as compared with beam vertical. This alters to some extent the setting of the quadrant. A suggested means of holding the mirror in such instances

is to insert small sections of asbestos or cork between the edge of mirror and the clamps that hold it. Rigid material should not be used for this purpose because of risk of breaking the mirror.

26. Orientation of lamp within projector.- Examination of lamps with C-5 filament will disclose that the luminous windings form roughly an incomplete circle as viewed from the end opposite the base. The complete portion should be toward the mirror. Most projectors are fitted with a lamp socket stem that may be rotated slightly for this purpose and then clamped in place.

27. Caution.- Some cases of severe burns have been reported due to reflection from the mirror when the sun shines upon it. A clean soft cloth or paper temporarily spread over the mirror will stop reflection while the focusing is being done. Or a time can be chosen when the sun is obscured by clouds.

28. Directing beam to zenith.- The mirror should first be inspected to make sure that it does not slip edgewise within its clamps when the projector is turned to position beam horizontal as compared with position beam vertical. Then the axis on which the drum rotates must be permanently fixed in an assured horizontal position. Methods that have been suggested to accomplish this are: To level across the outer flange of the closed door, the spirit level or a straight edged strip of wood to carry it resting on blocks of wood of equal thickness placed on opposite sides of the door flange; to level across the edges of the mirror itself, using a parallel sided strip of wood slightly shorter than the inside diameter of the drum as a rest for a small spirit level. After the axis has been set horizontal, the correct position in the plan of rotation must be assured. Most projectors are equipped with quadrants so arranged that after the beam has been once set vertical the drum may be lowered for examination and subsequently returned to the vertical position as indicated by marks or stops on the quadrant. Also some quadrants have faced leveling perches for a small spirit level. These devices, while helpful, are not considered entirely dependable, and hence verticality should be checked by sighting a plumbline against the beam from two positions; one in line with the axis the other at a right angle thereto. This check by plumb line should be made with the lamp in focus. When impracticable of performance because of daytime visit by inspector, arrangements should be made to have the check made by the observer and subsequently reported to the inspector by him.

29. Care of projectors.- Cover glass and the exposed (concave) side of mirror should be kept clean and dry by the methods customarily employed in cleaning glass. (The silvering is on the back of the mirror). Ordinarily wiping off the surfaces with a soft damp cloth will suffice, but if oil or grease should be present a little soap may be used if subsequently removed with clean water. Abrasive material should never be used. Regular and systematic attention at least once a week is essential. Reasonable effort should be made to exclude water; but since water is sometimes found in the mirror, either through leakage or by condensation, later models have had a one-fourth inch drainage hole drilled through the center of the mirror, with a corresponding drainage hole drilled

through the drum. Some stations report that calking compound placed around the outside at junction of cover glass with door frame has been found satisfactory in excluding water.

30. Repairs.- When major repairs become necessary it will probably be best to contact some trustworthy local concern who in turn should be able to procure parts from the manufacturer whose name appears on the projector. In ordering parts from the manufacturer, the contractor should give description and dimensions of each part needed as well as the manufacturer's serial number. When it becomes necessary to have resilvered a mirror not provided with drainage hole, a drainage hole should be drilled at the same time, the Weather Bureau to assume the considerable risk of breakage. Such drilling however should be performed by a mechanic who has had previous experience in drilling glass. The drum should be drilled also, and the hole screened to exclude insects. Expenditures must be authorized in the prescribed manner before any such work is performed.

31. Value.- The cost of projectors has varied from \$58 to \$103; of replacement mirrors \$22 to \$35; of resilvering mirror, \$5. Cost of lamps each: G-30, 250 watt, \$1.00; G-40, 500 watt, \$2.40; T-20, 1000-watt, \$3.86.

32. Painting.- Aluminum paint is considered best for all parts except the interior of the drum, and the louvres. On these only dead black should be used.

In drafting these instructions the writer has drawn upon such sources of information as manufacturers' catalogs and text books, and has also had the benefit of letters from stations and of oral advice from employees of both the Weather Bureau and the Department of Commerce.

B. C. Kadel,
Chief of Division.

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Revision of General Specifications
dated June 5, 1935, for installing
ceiling light projectors.

